3/14/53

CONCRETE BASEMENTS

for Homes

Why the Home Owner Wants a Basement

- ✓ A basement makes a home more livable because it provides desirable space for work and play.
- ✓ The basement provides most economically the space required for storage, heating equipment, hot water supply, fuel, laundering, work shops and hobby rooms.
- ✓ A basement affords plenty of space to wash and dry clothes during winter months and on rainy summer days.
- ✓ It allows for orderly storage of trunks, screens, storm windows, paint, stepladders, garden tools, lawn furniture and similar household items.
- ✓ A basement provides cool space for storing canned goods, fruits and vegetables.
- ✓ In a basement recreation room, indoor games, dances and parties may be held without wear and tear on upstairs furniture and carpeting.
- ✓ A house with a basement occupies less lot area allowing more space for lawns, flowers and outdoor living.
- ✓ Consumer-preference surveys indicate that most people prefer homes with basements. Thus a home with a basement generally is easier to finance and has better marketability.

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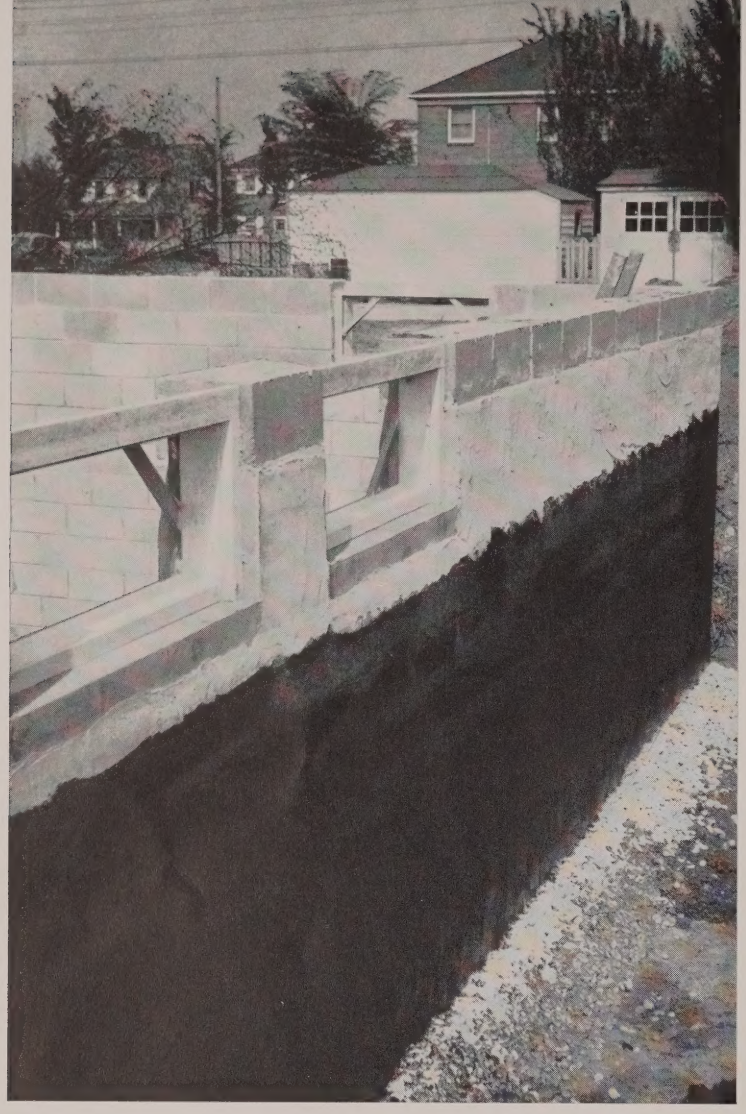

GOOD RESIDENTIAL CONSTRUCTION practice requires that footings for foundation walls be built on firm soil below possible frost penetration. As a certain amount of excavation must be done with or without a basement, valuable basement space can be economically provided with little additional excavation and depth of foundation walls.

A basement constructed of concrete walls, concrete footings and a concrete floor can be an attractive part of the home which will appeal to home owners both young and old. Working and living conditions will be comparable to those in above-grade interiors if recommended construction methods are followed.

Properly designed concrete footings prolong the life of the home by insuring uniform distribution of the loads on the soil. Proper design will also minimize unequal settlement and the possibility of basement walls cracking.

Concrete basement walls not only provide strong, stable support to the home but they are firesafe, decay-proof and long-lasting. Many rat-infested cities have passed ordinances requiring that buildings be made rat-proof with concrete basement walls and concrete floors.

Finally, concrete basement walls are one of the best-known barriers to termites. And the time to make a building termite-proof is when it is being built — not afterwards!

Diagrammatic map of the United States showing northern limits of damage by subterranean termites (*A-A*) and north limits of nonsubterranean or dry-wood termites (*B-B*). (Courtesy of Bureau of Entomology, U.S. Department of Agriculture). Photo shows typical termite damage to wood. Termites can't eat concrete.

1·Types of Basement Walls

Concrete basement walls are constructed of either cast-in-place concrete or concrete masonry units. The latter have become quite popular for building basement walls and often are less expensive than cast-in-place concrete which requires the use of forms during construction. Walls of cast-in-place concrete are recommended when there is a possibility of considerable ground water or water pressure, or severe earth pressure, as in deep basements or hillside locations. When severe stresses are expected, the cast-in-place concrete should be properly reinforced, and when subjected to concentrated loads the use of concrete pilasters may be required.

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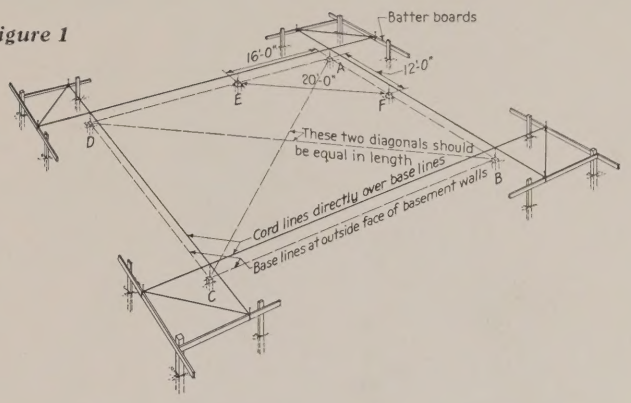
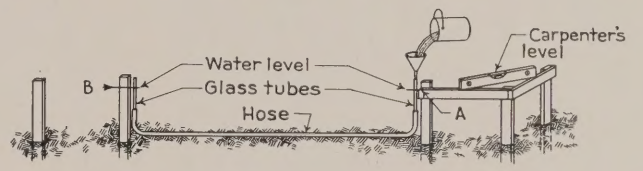
Figure 1



Right triangle method for laying out the foundation without use of surveying instruments.

1. **Lay out a line representing outside face of basement wall in accordance with local ordinances.**
2. **Set stakes at *A* and *B* on this line locating two front corners.**
3. **Use nails in tops of all stakes for accurate location of all corners and other points.**
4. **Set stake *F* on line *A-B* 12 ft. from *A*.**
5. **Stake *E* is placed 16 ft. from *A* and 20 ft. from *F*. Angle *EAB* is a right angle.**
6. **Extend *A-E* to *D* for third corner of basement.**
7. **Locate *C* by an intersection of an arc described from *D* having a radius equal to *A-B* and an arc described from *B* having a radius equal to *A-D*.**
8. **To check accuracy of layout, *A-C* must equal *B-D*.**
9. **Set up batter boards outside limits of excavation.**
10. **Tops of all batter boards are set at same elevation such as first floor level.**
11. **Stretch heavy cord tightly between batter boards directly over base lines thus establishing the building lines for construction purposes.**

Figure 2



Setting elevations of batter boards without surveying instruments.

1. **Set batter boards at one corner as at right.**
2. **Place hose as shown.**
3. **Fill with water until water level is at top of batter board *A*.**
4. **Mark water level at opposite end *B* and set board to mark.**

2 · Method of Laying Out the Foundation

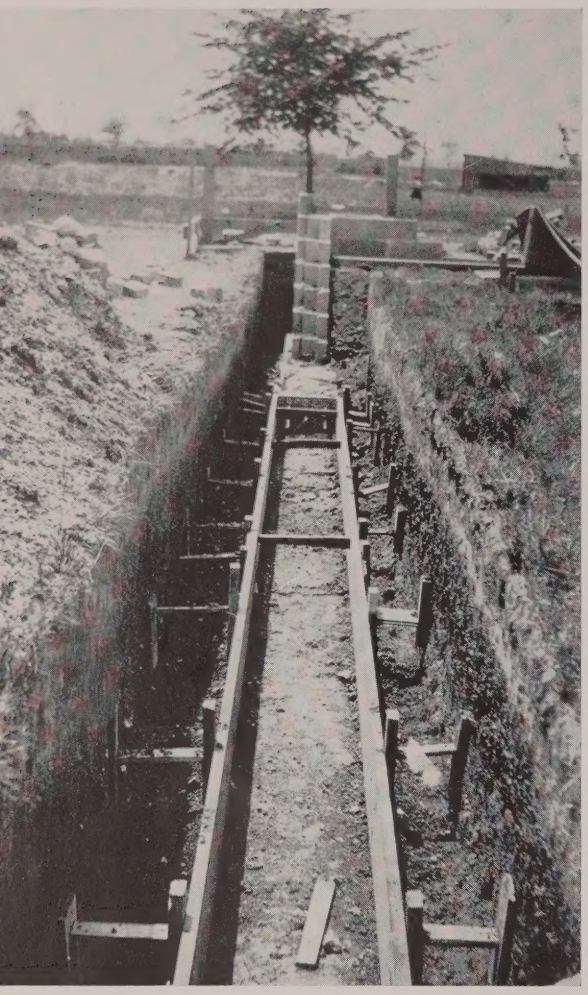
With surveying instruments, building lines and elevations of a new house can be laid out easily, quickly and accurately. When they are not available, the right triangle method is a simple way of laying out corners of the basement walls. This method is based on the fact that a triangle with sides 12, 16 and 20 ft. long or of similar proportions, is a right triangle and the 90 degree angle, or right angle, is opposite the longest side. By applying this principle, building lines can be laid out perpendicular to each other. See Fig. 1. A simple method for setting elevation of batter boards without surveying instruments is shown in Fig. 2.

Building lines and grades are easily set with surveying instruments.

3 · Excavation

All organic matter such as sod, bushes, trees, etc. within the limits of the proposed excavation should be removed. The first 12 in. of the top soil should be stripped and stockpiled to be used later in grading and landscaping the property.

Excavations for footings must extend to firm soil and at least 6 in. below frost line, even though firm bearing soil is found at a shallower depth. Footings placed at this depth will not be affected by frost upheaval.



Forms for footings are securely staked on firm soil below frost line.

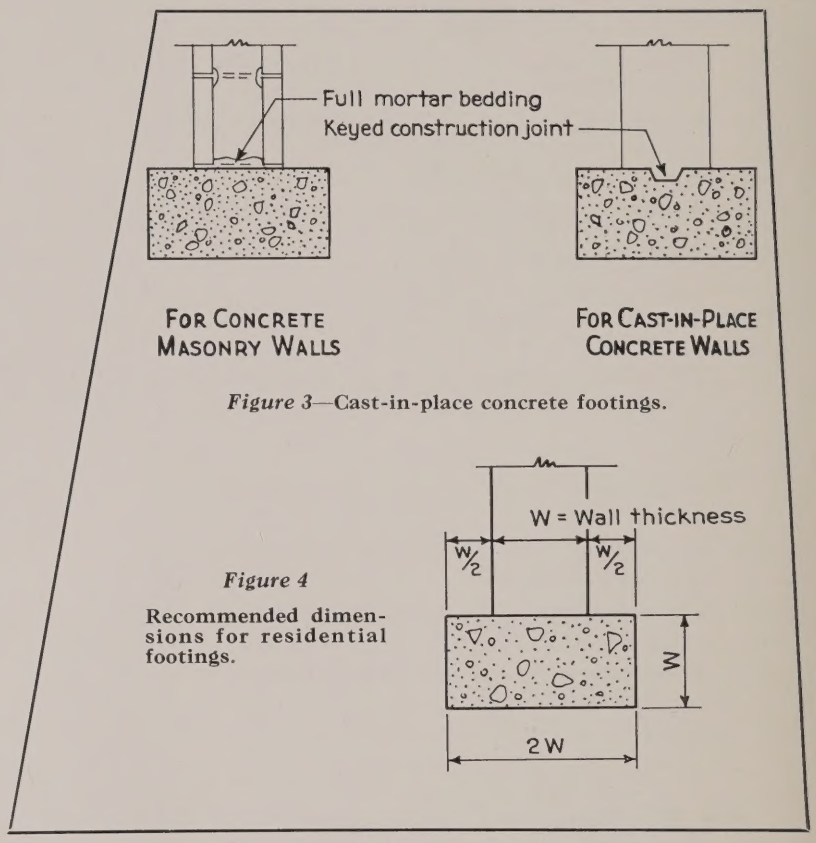


Figure 3—Cast-in-place concrete footings.

Figure 4

Recommended dimensions for residential footings.

4 • Footings for Foundation Walls

Cast-in-place concrete footings should be provided for all foundation walls. Concrete is ideal for constructing footings as it readily conforms to any slight irregularities in the subgrade, thereby insuring uniform bearing on the soil (Fig. 3).

Footings should be properly designed to distribute the loads uniformly over the supporting soil. They should also meet local building code requirements. In the absence of a code, general practice is to build residential footings having a depth equal to the thickness of the foundation wall and a width equal to twice the wall thickness (Fig. 4).

Footings must always be constructed on a horizontal plane. When questionable soil conditions are encountered, such as soft or filled ground or poorly drained soils, footings should be reinforced with steel bars. Footings which bridge trenches or other unstable areas should also be reinforced. The reinforcement will hold the footings together and prevent the formation of any large cracks which might otherwise result from uneven settlement. In any case the addition of a longitudinal reinforcing steel will increase the stability and useful life of the structure.

Footings which support cast-in-place concrete walls should be cast with a recess to form a keyed construction joint with the wall as shown in Fig. 3.

When chimney footings are independent of other footings, they should have a minimum thickness of 8 in. and a minimum projection of 4 in. on each side in a one-story dwelling. For the two-story house, chimney footings should have a minimum thickness of 12 in. and a minimum projection of 6 in. on each side. Exact dimensions should be determined from the weight of the chimney and the bearing capacity of the soil. Where chimneys occur in outside walls or inside bearing walls, chimney footings should be constructed as part of the wall footing. Concrete for chimney and wall footings should be cast integrally.

5 · General Requirements for Basement Walls

Basement walls extend from the top of the footings to the first floor and must be of sufficient strength and thickness to resist lateral pressures from adjacent earth or water and to support their vertical loads with an ample factor of safety.

Cast-in-place or concrete masonry basement walls must be at least as thick as the walls immediately above them. Basement walls of the cast-in-place type must have a thickness of at least 8 in. Concrete masonry basement walls must have a nominal thickness of at least 12 in., except that when the walls do not extend more than 4 ft. below the ground line they may have a nominal minimum thickness of 8 in. The local building commissioner may, however, approve the use of 8-in. concrete masonry basement walls to a depth of 7 ft. where soil conditions justify such an extension. In no case shall the total height of 8-in. concrete masonry walls including the basement walls exceed 35 ft. When the walls exceed 35 ft. in height the basement walls must have a nominal thickness of 12 in. See Fig. 11, page 13, for nominal and actual masonry unit sizes.

Basement walls should extend at least 8 in. above outside finished ground level. Windows and doors should provide cross ventilation and the total area of these openings should be at least 2 per cent of the floor area enclosed.

6 · Provisions for Subsurface and Surface Drainage

Unless the structure is being erected in a section of the country having a dry climate, or the subsoil is well drained, a line of drain tile should be placed around the outside edge of the footing as shown in Fig. 5.

To provide drainage that will insure a dry basement, special care should be taken to place the tile at the side of the footing as is shown in the figure. Dirt sloughing off the sides of the excavation has a tendency to fill the place where the tile should be laid, and precaution should be taken against placing the tile on top of the footing instead of at the side.

At the low point, the bottom of the tile should be level with the bottom of the footing. It should have a slope of about ½ in. in 12 ft. and should drain to a suitable outlet. The tile should be divided into two branches running from the low point in opposite directions around the footing to meet at the high point.

Joints between the tile should be covered with pieces of roofing felt or other suitable material to prevent soil from entering the tile, and still allow ground water to enter the pipe. Coarse gravel or crushed stone ranging in size from 1 to 1½ in. should be placed over the drain tile to a depth of at least 12 in.

Downspouts should be connected to underground drains or arranged to discharge water away from the walls. Surface water should be drained away from the basement wall by proper grading.

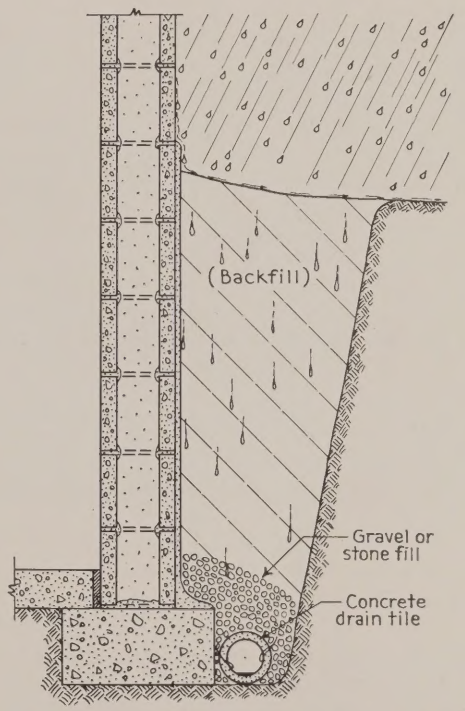
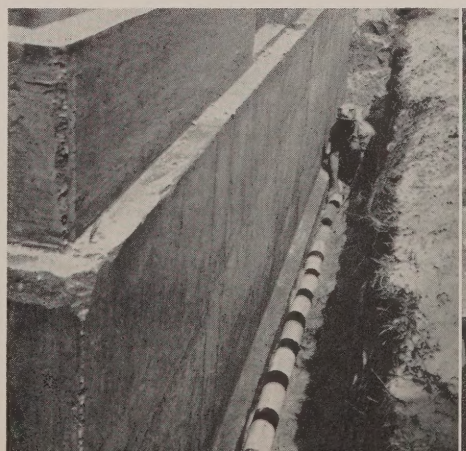
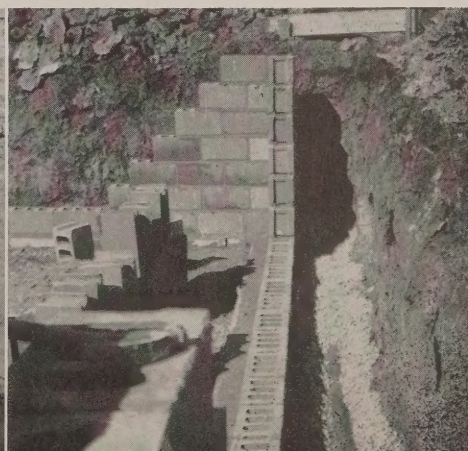


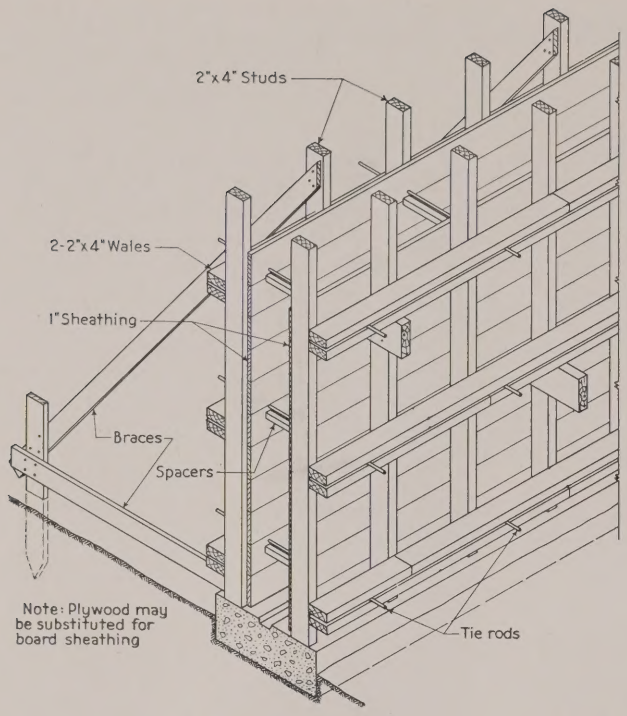
Figure 5—**Details of surface and subsurface drainage.**

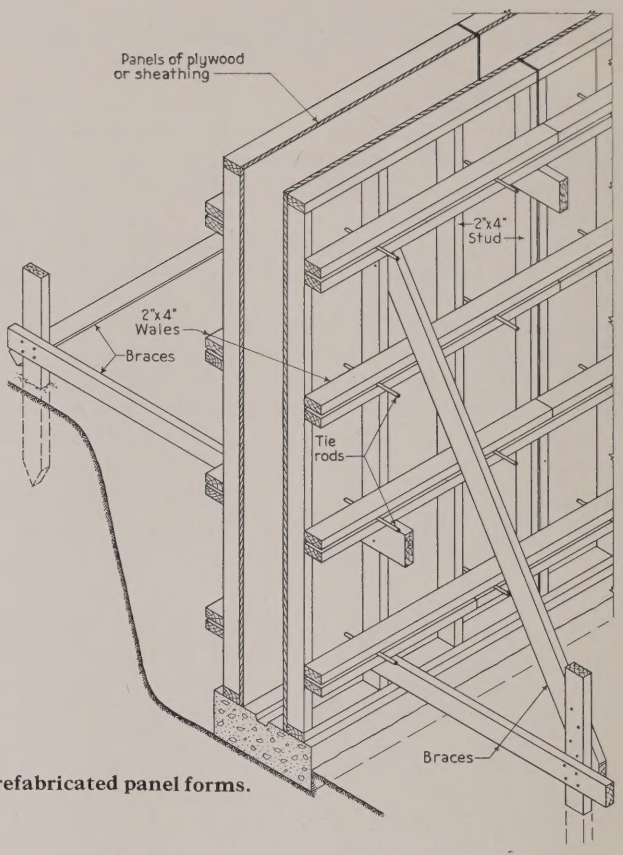


1. Drain tile is placed against footing with roofing felt covering joints between tiles.



2. Coarse gravel or crushed stone is placed over drain tile.





***Above, Figure 6*—Built-in-place forms.** ***Right, Figure 7*—Prefabricated panel forms.**

7 • Forms for Cast-in-Place Concrete Basement Walls

Forms should be carefully built and strongly braced to insure walls that are true to line and grade. Two types are commonly used for building cast-in-place concrete basements. Both should be good sound lumber free from loose knots and decay. Type one (Fig. 6) is the more conventional method of completely erecting the form structure in place using wood sheathing or plywood, studs, wales and bracing. Usually this method is used when the work volume is relatively small. The second type (Fig. 7) employs the use of prefabricated panels that are assembled on the job site. These panels are designed so they can be readily removed from one job and reassembled on subsequent work.

In the first method, 1-in. boards are commonly used for sheathing and when supported by 2x4-in. studs at 24-in. intervals, will withstand pressure without bulging from freshly placed concrete up to 3 ft. in depth. For placing concrete in depths greater than 3 ft., the studs should be placed at intervals closer than 24 in., or heavier sheathing must be used.

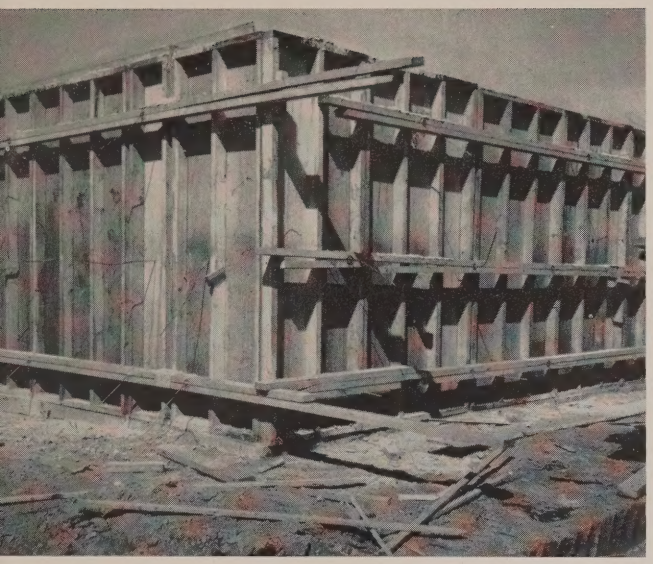
Prefabricated panels for forms used in the second method are usually made of wood or metal. Wood panels are made of sheathing and studs, plywood backed up by sheathing and studs, or plywood backed up only by studs. Metal panels are usually made from steel, and are small enough to be readily handled.

Desired smoothness of a wall often determines the choice of form materials. When a particularly smooth finish is wanted, plywood or form lining paper is frequently employed. Joints between form boards or panels should be tight to prevent loss of cement paste which would tend to weaken the concrete and result in honeycombing.

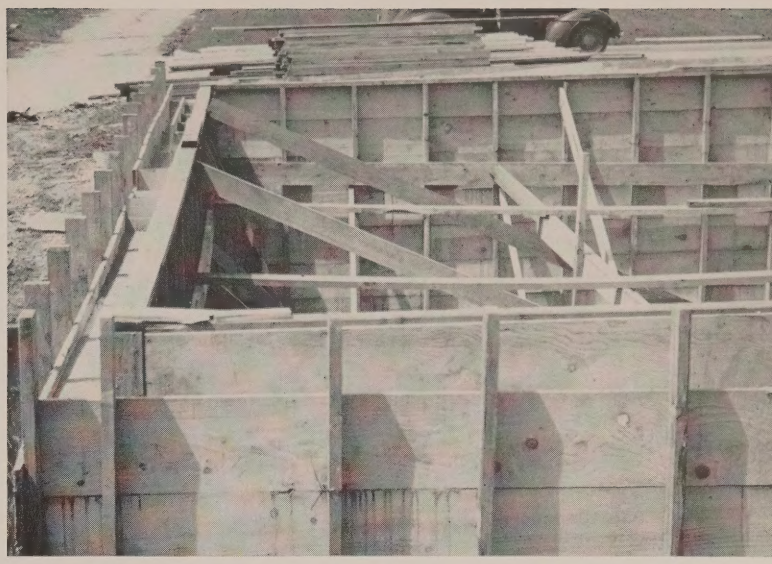
Wire ties are used to keep the two form faces from spreading apart. Soft black annealed iron wire is commonly used for tie wire. It is strong in tension and will withstand the severe twisting that is necessary in tightening. These wires are cut flush with the wall surface when the forms are removed.

In many instances tierods or patented ties are replacing the conventional wire ties. In general these are easier to install and their use cuts labor costs. Because of greater cross-sectional area it is not necessary to space them as closely as wire.

When spreader attachments are not part of the ties, wood spacers are commonly used to keep the inside faces of the forms the proper distance apart. These are cut to a length equal to the desired wall thickness and are placed between the forms before the ties are

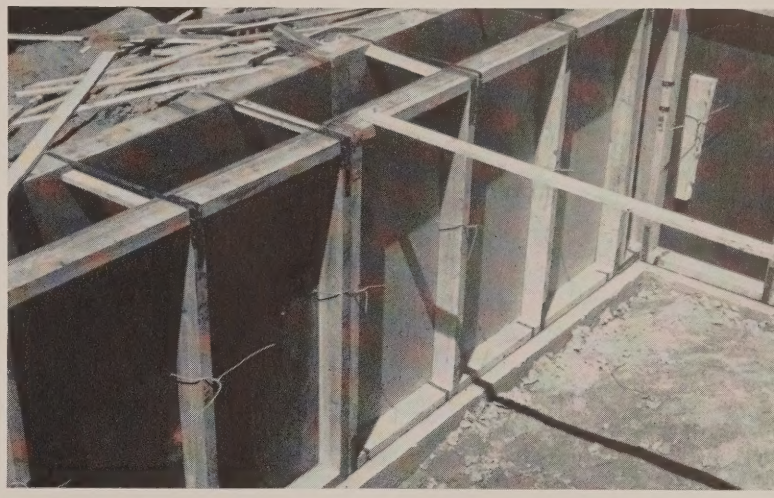


Prefabricated panel forms.



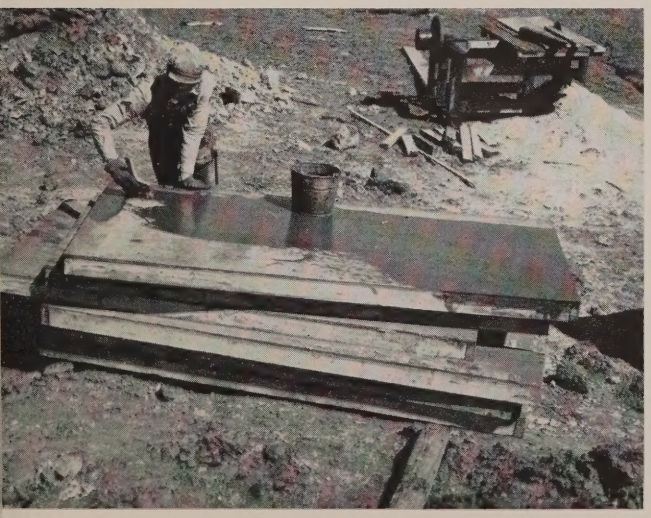
Forms built of ordinary sheathing.

Making prefabricated plywood panels.

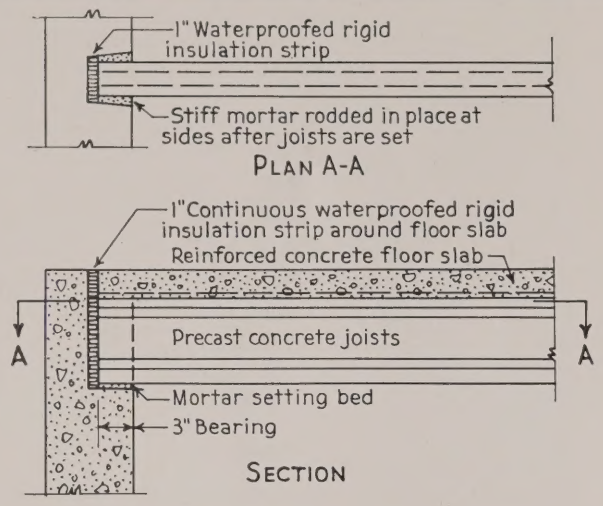


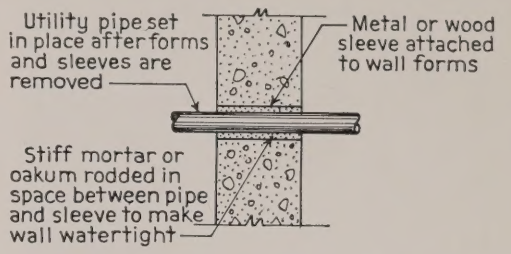
Prefabricated plywood panels completely assembled. Note wire ties, metal strap ties, and wood spacers.

Oiling prefabricated forms before assembling.



Cleaning forms after stripping.




Utility pipe set in place after forms and sleeves are removed
Metal or wood sleeve attached to wall forms
Stiff mortar or oakum rodded in space between pipe and sleeve to make wall watertight

Left—Figure 8

Method of providing joist pocket in basement wall.

Above—Figure 9

Method of providing sleeves through a basement wall for utilities.

tightened. These spacers are removed as the placed concrete reaches their level.

Many of the patented ties have weakened sections which allow the metal to be broken off about an inch and a half inside the wall face when the forms are removed. When the broken tie is removed, the resulting hole is patched with mortar, completely embedding the remaining portion of the tie and providing a smooth surface.

To prevent the concrete from sticking to the forms, crude oil, soft soap, or whitewash should be painted on the form faces. Lacquering is sometimes employed for this purpose, especially on plywood forms.

At the time the forms are being constructed, provisions should be made for attaching buck frames for window and door openings. The buck frame should fit tightly between the form faces to prevent leakage of mortar or displacement during concreting operations.

If precast concrete joists are to be used, pockets sometimes are built at the top of the basement wall form (Fig. 8). These pockets should be anywhere from ¼ to ½ in. larger on each side than the joist itself and spaced according to the floor framing plan. The pocket form should be beveled and oiled for easy removal.

Openings in the basement wall to accommodate the passage of utility connections are formed by metal or wood sleeves attached to the wall form (Fig. 9). After the forms and sleeves are removed, the utility pipe is set in place. To make the wall watertight, the space between the pipe and sleeve should be tightly calked with oakum or filled with stiff mortar.

Forms should be cleaned promptly after stripping.

8 • Quality Concrete for Cast-in-Place Basement Walls, Floors and Footings

Concrete is a mixture in which a paste made of portland cement and water binds fine and coarse materials known as aggregates into a rock-like mass as the paste hardens.

It usually costs no more to make good quality concrete than poor quality concrete. Good concrete is far more economical in the long run because of its greater durability. A few simple rules, closely followed, assure concrete of high quality.

Ingredients used in making concrete are: portland cement, fine aggregate, coarse aggregate and water.

Each sack of portland cement holds 94 lb., equal to 1 cu. ft. in volume. When used, the cement should be a free-flowing powder. Cement should be stored in a dry place so that it will not absorb water and get lumpy. If it contains lumps that cannot be pulverized easily between thumb and finger it should not be used.

Fine aggregate consists of sand or other suitable fine material graded from dust to ¼ in. in size.

Coarse aggregate consists of gravel, crushed stone or other suitable material graded from ¼ in. to ¾ in. or larger, whichever is practicable for the job. Coarse aggregates that are sound, hard and durable are best suited for making concrete. Aggregates that are soft, flaky, or that wear away rapidly are generally unsatisfactory.

Mixing water should be clean. A good rule is to use water suitable for drinking.

The amount of mixing water per sack of cement determines the durability, watertightness and strength

of the concrete. In general the less mixing water used, the better the quality of the concrete so long as the mixture is plastic and workable. Some concrete jobs must be stronger and more watertight than others; therefore, less mixing water is used in making concrete for such work. Six gal. of water to each sack of cement are recommended for basement footings, walls, floors and stairs.

Most fine aggregate contains some water which combines with portland cement. Therefore, allowance must be made for this moisture in determining the amount of water to be added to the mix. Allowance has been made in Table I for the amount of water contained in average wet sand.

If the proportions suggested in Table I do not make a workable mixture in the first trial batch, it may be necessary to vary the proportions of fine and coarse aggregates slightly from those given to obtain a smooth, plastic, workable mix. The amount of cement or water should not be varied from the quantities shown. If the trial proportion used results in a mix that is too wet, fine and coarse aggregates in small amounts should be added until the right degree of plasticity is obtained. If the mix is too stiff, the amounts of fine and coarse aggregates in the next batch should be cut down until the right consistency is obtained. In this way the best proportions for the job can be determined to insure good quality concrete.

TABLE I—Recommended CONCRETE Mixes for Basement Footings, Walls, Floors and Stairs

Size of aggregate	Trial Mixes			
	Mixing water* per sack of cement	Portland cement	Aggregates	
			Sand	Gravel or crushed stone
	U.S. gal.	Sacks	Cu.ft.	Cu.ft.
Maximum size ¾ in.	5	1	2½	2¾
Maximum size 1 in.	5	1	2¼	3
Maximum size 1½ in.	5	1	2¼	3½

*Based on 6 gal. of water per sack of cement including water contained in damp sand.

9 · Mixing Concrete

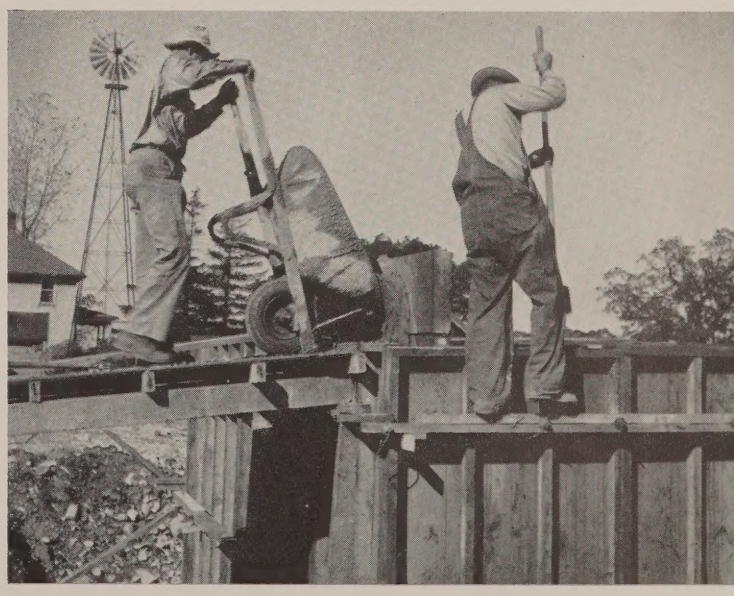
Concrete should be mixed thoroughly until it is uniform in appearance, with all ingredients evenly distributed. Machine-mixing is preferred and should continue for at least one minute after all the materials have been placed in the mixer. The concrete should be placed in the forms promptly, but in any case within 45 to 60 minutes after mixing. When delay in placing occurs, and the concrete has stiffened, it may be used if its workability is restored by remixing. Under no circumstances, however, should water be added.

10 · Placing Concrete

The method used to move concrete from the mixer to its final position will depend largely upon job conditions. Wheelbarrows are commonly used. Rubber-tired barrows are easier to wheel, and there is less jarring that might cause the coarse and fine particles to separate.

Concrete should be placed as nearly as practicable in its final position. To avoid segregation, it should not be placed in large quantities at a given point and allowed to run or be worked over a long distance.

In general, concrete for walls should be placed in the forms in horizontal layers of uniform thickness not exceeding 6 to 12 in. deep. As the concrete is placed, it is spaded or vibrated just enough to compact it thoroughly and produce a dense mass. Working the concrete next to the forms tends to produce a smooth dense surface, free from honeycombing, along the form faces. A spade or thin board may be used for this purpose. Thus the large aggregates are forced away



Placing and spading concrete.

Working concrete next to form to produce smooth surface.

Stripping prefabricated panel forms.

from the forms and any air that may have been entrapped along the form face is released.

Mechanical vibrators are most efficient in consolidating concrete, and permit use of stiffer mixes than when concrete is spaded by hand. However, vibrators create an increased pressure on the forms and this factor must be considered in their design. The vibrator should not be held in one location long enough to draw a pool of grout from the surrounding concrete.

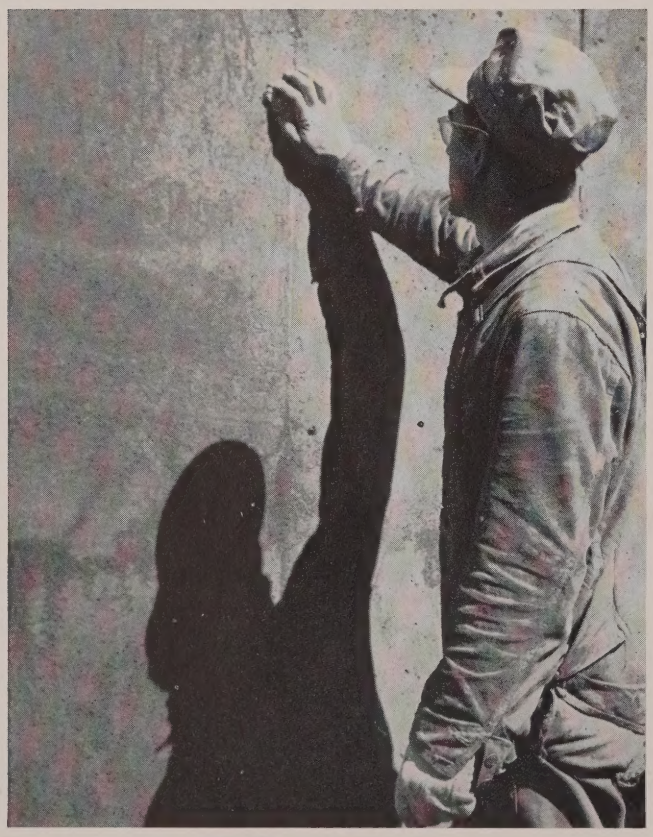
As successive layers of concrete are placed in the wall, the water content of the mix should be decreased progressively to offset the water gain from the lower layers. If this is not done, the concrete becomes wetter than intended with consequent loss of durability and strength in the upper layer. Its nonuniformity will result in discoloration and formation of laitance.

To avoid construction seams, it is desirable to complete a basement wall in one continuous operation. If work is stopped before a wall can be finished, the concrete should be leveled in the forms. Just before the concrete hardens, the top surface is roughened to remove laitance or scum and provide a good bonding surface for the next layer of concrete. Unless care is used in providing a good bond between successive layers of concrete, seams may develop and cause leakage.

Before depositing a new layer on the hardened concrete, the top surface should be coated with a cement-water paste mixed to a thick creamy consistency. This paste is applied in a thick brush coat just a few feet ahead of the concreting operations so that it does not have a chance to dry before the fresh concrete is placed.

In warm weather wall forms can usually be stripped after one or two days and in the cooler weather of spring or fall in from four to seven days.

To remove all form marks and provide a smooth surface, all exposed inside and outside surfaces can be rubbed with a carborundum stone and a mixture of portland cement and water.



Removing form marks with carborundum stone.

11 • Curing Concrete

To attain the desired durability, watertightness and strength, the concrete should be properly cured. Concrete will harden as long as temperatures are favorable and moisture is present to hydrate the cement.

Concrete should be kept damp during the entire curing period. In the case of walls, the concrete should be protected from loss of moisture as soon as forms are removed by coverings of burlap or other suitable absorbent material which can be kept saturated with water. For basement floors and footings the concrete is kept damp by covering with canvas, burlap, sand, dirt or straw, which are kept wet. Sometimes floors are kept damp by covering with watertight paper.

The length of time the concrete should remain damp depends on the temperature of the concrete and the type of cement used. For air temperatures of 70 deg. F. or more, the concrete should be kept moist for at least 7 days with normal portland cement or 3 days with high-early-strength portland cement. For temperatures between 50 and 70 deg. F. the concrete should be kept moist for a least 12 days with normal portland cement and 7 days with high-early-strength portland cement. The time during which the forms are in place can be counted as part of the curing period.

When concreting is done at temperatures below 50 deg. F. protective measures to insure proper curing and hardening should be taken as described in section *12 • Cold Weather Concreting.*

12 • Cold Weather Concreting

By observing certain precautions, concrete can be placed safely even in cold weather if the fact is kept in mind that heat accelerates and cold retards hardening of concrete.

Where practicable, the excavation and subgrade should be prepared before freezing weather sets in, and covered with material such as straw to protect it against freezing. Concrete should never be placed on frozen ground as subsequent thawing may cause settlement. All snow and ice should be removed from within the forms.

In weather during which the temperature is generally above 40 to 45 deg. F. with only short periods below this range, a covering of tarpaulins may be enough to maintain the freshly placed concrete at a favorable temperature for curing. As the weather grows colder, near freezing, heating the mixing water or heating the concrete in the mixer, together with protection from freezing, may be sufficient to provide favorable curing temperatures. In cold weather, near 20 deg. F., it is often necessary to heat both the mixing water and aggregates and to cover the fresh concrete or to provide a heated enclosure.

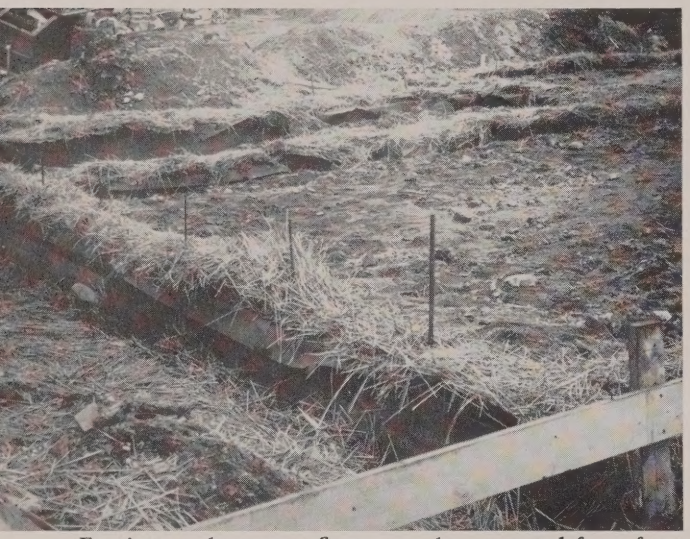
The mixing water must never have a temperature higher than 165-175 deg. F. when it comes in contact with the portland cement, because of the possibility of causing a flash set of the cement. The temperature of the aggregates when placed in the mixer should not exceed 100 deg. F. In no case should the materials be heated to the point that the temperature of the fresh concrete is above 80 deg. F. This results in lower strength. Cement should not be heated. No ice or snow or frozen lumps of aggregate should be placed in the mixer.

Oil-burning heaters may be used for heating concrete in the mixer. On many days this may be sufficient.

Water may be heated by injecting live steam or by a pipe coil in a heated tank.

Aggregates are often piled over steel pipe in which a fire is built to remove frost and ice from aggregates.

Tarpaulins may be used to provide heated enclosures in freezing weather.



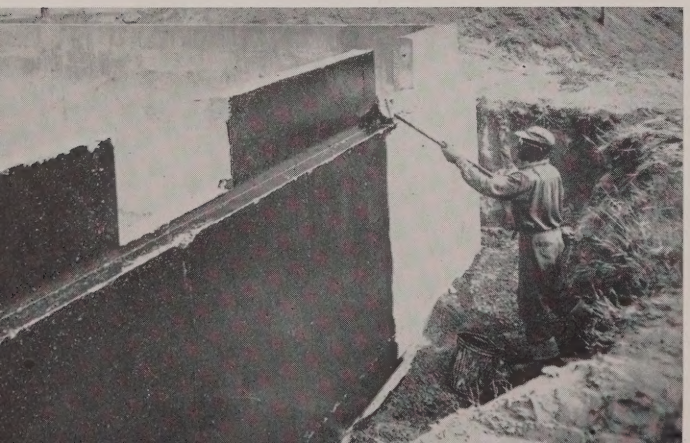
Footings or basement floors may be protected from frost by coverings of straw.

As soon as the concrete is placed it is protected to retain its heat and moisture. Concrete footings, basement floors and other flat surfaces can be protected by covering with heavy paper and then with hay or straw, 10 to 12 in. deep. Basement walls can be protected by coverings of canvas tarpaulins which will retain the heat. Such canvas enclosures heated with live steam or salamanders will provide excellent protection from freezing. When left in place the forms assist in retaining both heat and moisture.

In general, when outdoor temperatures are near freezing, the concrete should be so protected that its temperature is maintained at not less than 70 deg. F. for the first three days after placing, or not less than 50 deg. F. for the first 5 days. In cold weather, near 20 deg. F., it is desirable to provide protection for a somewhat longer period.

Under similar conditions concrete intended to develop high early strength requires a shorter period of protection than ordinary concrete. Concrete of high early strength can be obtained with high-early-strength portland cement, with richer mixes of normal portland cement, or by the addition of calcium chloride. The quantity of calcium chloride used should not exceed 2 lb. per sack of normal portland cement. Calcium chloride is an accelerating agent and the quantities used are not sufficient to reduce materially the freezing temperature of the concrete. It should not be used as a substitute for heating the water and aggregates.

13 • Basement Walls of Cast-in-Place Concrete



In well-drained locations, concrete that is properly proportioned, placed and cured will provide sufficient protection against moisture penetration. In poorly drained soils, the exterior surface of the basement wall should be given two continuous coatings of hot bitumi-

Applying hot bituminous material to basement walls as an added precaution in poorly drained soils.

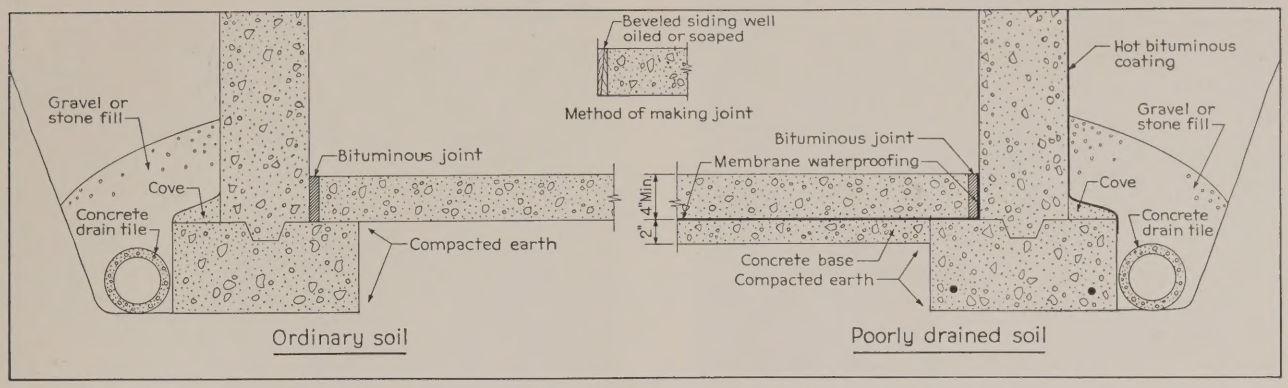


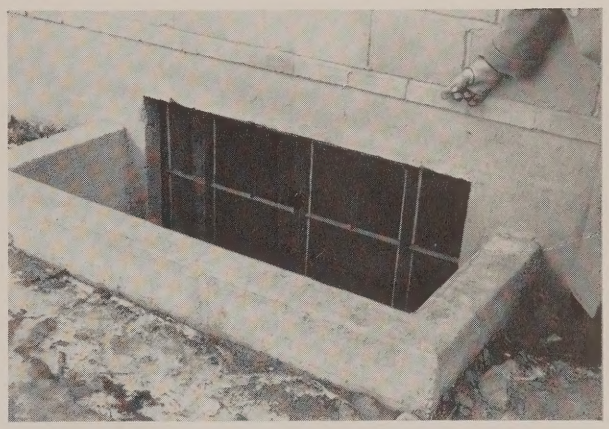
***Figure 10*—Basements with walls of cast-in-place concrete.**

nous material applied with brush strokes at right angles to each other over a suitable priming coat*, extending from 6 in. above the ground line down over the top of the footing (See Fig. 10). When severe ground water conditions are encountered, thicker walls and special reinforcement may be required.

At the time of placing the concrete for foundation walls, dowels should be provided and placed in the concrete for all connecting walls and areaways.

Anchor bolts should be placed in the top of cast-in-place concrete basement walls when they are to support frame construction. The usual practice is to use ½x8-in. bolts on 4-ft. centers for attaching wood sills. Bolts are set in cast-in-place walls at time concrete is placed.

*Coal-Tar Pitch ASTM D450-41 Type B and Creosote Primer ASTM D43-41; or Asphalt ASTM D449-42T Type B and Asphalt Primer D41-41.



Cast-in-place concrete areaways are tied to basement walls with dowels set during construction.

14 • Basement Walls of Concrete Masonry

Hollow concrete masonry is often more convenient than cast-in-place concrete for the construction of basement walls. The masonry units are laid up quickly and economically and provide strong, stable walls. No forms are required with this type of construction.

Concrete masonry is made with various types of aggregate such as sand, gravel, crushed stone, cinders, expanded clay or expanded slag. These units should comply with local building code requirements as to strength, absorption and moisture content. In the absence of a local building code, units complying with applicable ASTM specifications should be used.

Concrete masonry should be laid up with a mortar composed of one of the proportions given in Table II. The mortar selected depends upon the type of wall to be constructed.

The first course of masonry should be placed on the concrete footing using a full bed of mortar as shown in Figs. 3 and 12. This is the only full mortar course that is used in ordinary concrete masonry wall construction. Succeeding courses are laid by using face-

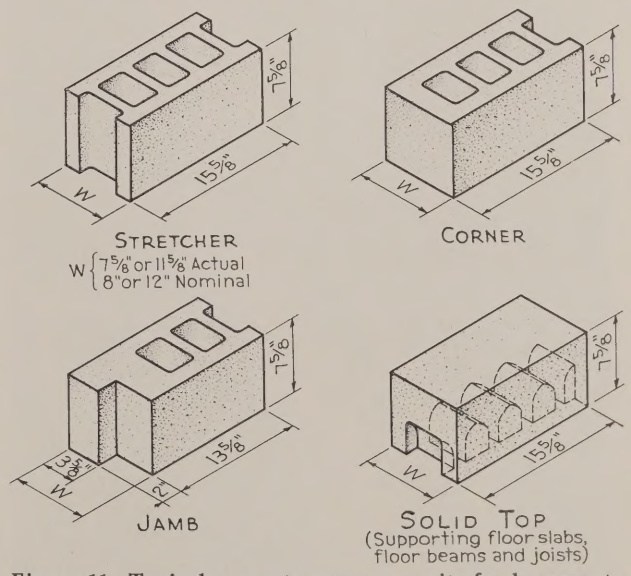


***Figure 11*—Typical concrete masonry units for basement construction.**

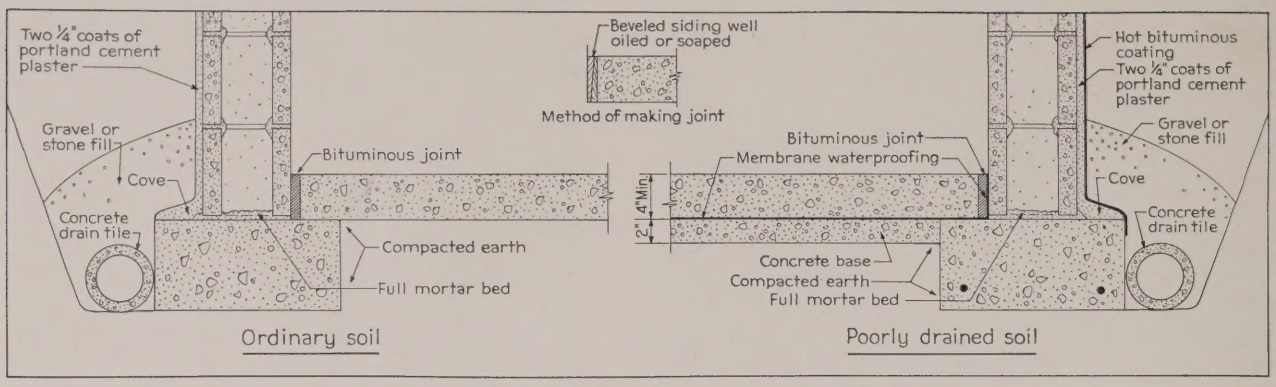


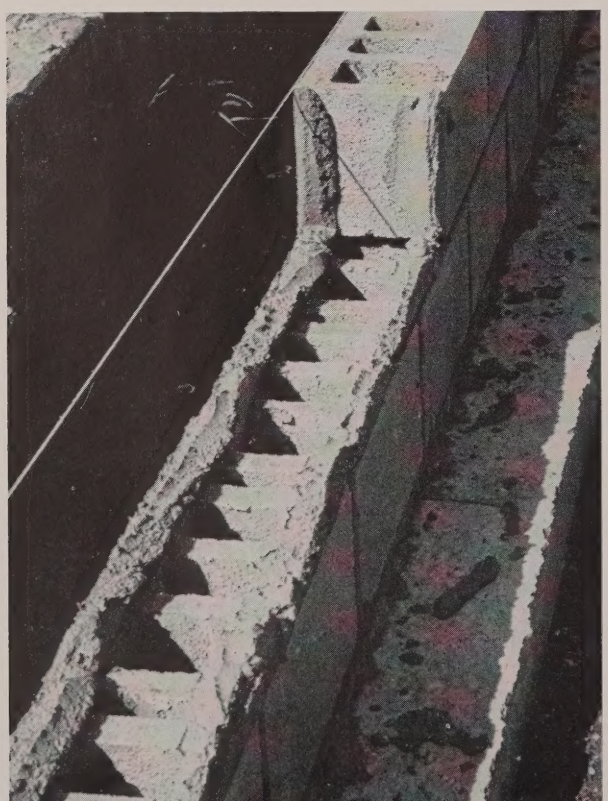
Figure 12—**Basements with walls of concrete masonry.**

TABLE II—Recommended MORTAR Mixes Proportions by Volume

Type of service	Cement	Hydrated lime or lime putty	Mortar sand in damp, loose condition
For ordinary service	1-masonry cement*	—	2 to 3
	or		
	1-portland cement	1 to 1¼	4 to 6
Subject to extremely heavy loads, violent winds, earthquakes or severe frost action. Isolated piers.	1-masonry cement* plus 1-portland cement	—	4 to 6
	or		
	1-portland cement	0 to ¼	2 to 3

*Federal Specifications SS-C-181b, Type II.

Concrete masonry is laid with horizontal and vertical face-shell mortar bedding.



shell bedding with full mortar coverage on vertical and horizontal face shells.

A good practice to follow in order to insure well-filled, watertight "head" joints is to apply mortar to the vertical face shells of both the unit just laid and the unit next to be placed.

The course of concrete masonry supporting floor slabs, floor beams or joists shall be constructed by filling the cores of the units with concrete or by using a solid top block in accordance with local requirements.

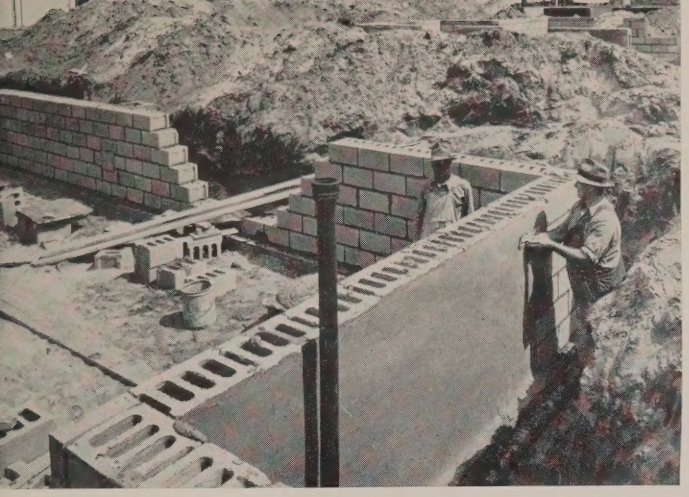
Mortar joints should be ⅜ in. thick and should be tightly compacted after the mortar has stiffened, with a V-shaped or rounded tool having a diameter slightly larger than the thickness of the joint.

The earth side of concrete masonry basement walls should be covered with portland cement plaster applied in two coats ¼ in. thick extending from 6 in. above the finished ground line down to the footing. The plaster should be made in the proportions of 1 volume of portland cement and 2½ volumes of damp, loose mortar sand. Wall surface should be dampened prior to application of first coat. First coat should be roughened after it has partially set and then permitted to harden for at least 24 hours before the second coat is applied. The first coat should be dampened before second coat is applied. The second coat should be kept damp for at least 48 hours after application. At the junction of the outside wall face and the footing, the plaster should be thickened and rounded to form a cove to divert water from the base of the wall (See Fig. 12).

In poorly drained soils, the exterior surface of the plaster should be given two continuous coatings of hot bituminous material applied at right angles to each other over a suitable priming coat*, extending from 6 in. above the ground level down over the top of the footing.

Concrete masonry must be protected in cold weather until the mortar has had time to gain the desired strength. At moderately cold temperatures of less than 40 deg. F., the wall should be protected with a

*Coal-Tar Pitch ASTM D450-41 Type B and Creosote Primer ASTM D43-41; or Asphalt ASTM D449-42T Type B and Asphalt Primer D41-41.



Concrete masonry basement walls should be covered with two coats of portland cement plaster.

Many old homes can be modernized with a concrete basement.

covering of tarpaulin. In extremely cold weather the concrete masonry units should be kept in a heated shelter until a short time before using, and the water and mortar sand should be heated, subject to the same precautions as noted in section *12 • Cold Weather Concreting*. It is desirable to protect the new masonry work for the same length of time as cast-in-place concrete.

When wood sills are to be placed on top of the concrete masonry basement wall they should be fastened to the masonry by means of ½x18-in. anchor bolts spaced 4 ft. on centers. The anchor bolts are placed in the cores of the last two courses of masonry. These cores are then filled with concrete. A piece of metal lath or wire screen is placed in the lowest mortar joint under the cores to be filled to hold the concrete while it hardens around the anchor bolt.

No filling against the concrete masonry basement walls should be permitted until the first floor is in place. Such precautions are necessary to insure sufficient bracing for the wall against lateral earth pressure.

Mason laying course of solid-top block to support floors and joists. These block are made with top 4 in. solid.

15 • Basement Floors of Concrete

The concrete basement floor slab is commonly placed directly on the earth. In the case of poorly drained soils, however, a fill of coarse gravel or crushed stone 4 to 6 in. thick should be placed to provide a dry base for the concrete. The fill should be provided with a tile drain connected to a suitable outlet. In either event, the base for the floor must be thoroughly compacted.

The basement floor should be not less than 4 in. thick and preferably of one-course construction. In cases where there may be pressure from groundwater or other causes, this thickness should be increased and the slab designed as a reinforced concrete slab and anchored to the walls or footings to meet the additional pressure.

The concrete after placing should be thoroughly compacted by tamping and spading, after which it should be struck off with a straightedge and woodfloated to proper grade. Woodfloating should be discontinued when the surface becomes wet. After the water sheen produced by floating has practically disappeared, the surface should be troweled to a smooth finish. Smooth finishes are produced with a steel trowel, care being taken to prevent too early troweling or excessive troweling. The best practice is to allow the concrete to stand until it is quite stiff but is still workable. Then the steel trowel compacts the concrete and produces a dense surface. When the mixture is quite stiff, cement and fine materials are not drawn to the surface under the action of the trowel. This care is required because troweling too soon or too much is likely to result in surfaces that will dust or which may develop numerous fine cracks called "hair-checks."

Woodfloat is used to level the concrete to proper grade.

Final floor finish is obtained by steel troweling after water sheen produced by floating has practically disappeared.

As soon as the concrete has hardened enough to prevent damage to the surface, it should be cured. See section *11 • Curing Concrete.*

The joint between the walls and floor (See Figs. 10 and 12) should be filled with a hot bituminous material. Two beveled strips of wood, such as ordinary siding, inserted when the floor is laid and removed after the concrete has hardened, can be used to form the groove.

The bituminous material used to fill the joints should be of such a nature and consistency that it will not bleed and should be carefully placed so as to not quite fill the joints. After it has hardened sufficiently it should be dusted with cement and if desirable painted with portland cement paint.

As a further precaution under extreme ground-water conditions, the floor is placed in two layers with a membrane waterproofing* between as shown in Figs. 10 and 12. The concrete base course when hardened and dried should be mopped with hot bituminous material. As the mopping proceeds and before the application has time to cool and harden, a layer of 15-lb. roofing felt should be placed on the bituminous coating with edges of felt well lapped. Two layers of roofing felt are recommended with hot bituminous material mopped between layers and also on top of the second felt. This membrane waterproofing should be continuous over the entire floor area and carried up on the inside of the foundation walls to floor level. Workmen must be cautioned against puncturing the membrane when placing the concrete floor.

Drains in the basement floor should be set in place and connections completed to a suitable outlet outside the basement walls before the concrete is placed. The finished floor surface should slope toward the drains.

*Coal-Tar Pitch ASTM D450-41 Type B and Coal-Tar Saturated Roofing Felt ASTM D227-44; or Asphalt ASTM D449-42T Type B and Asphalt-Saturated Roofing Felt ASTM D226-44.

Joint between floor and wall is filled with hot bituminous material.

Membrane waterproofing over a base course insures dry basements under extreme ground water conditions.

16 · Finishes for Basement Floors

Concrete basement floors can be finished in various ways. The concrete slab can be troweled smooth and left in its natural color or it may be given a linseed oil treatment or waxed and polished.

One method of coloring a concrete floor is to incorporate commercially pure mineral oxide pigments in a topping mixture which is placed to a depth of 1 in. over a plain concrete base slab. Mixing of cement and pigment is done before aggregate and water are added and should be very thorough to secure uniform dispersion and full color value of the pigment. Manufacturers' directions should be closely followed. Table III may be used as a guide for the approximate quantities of pigment required for various colors.

Another method is to use a dusted-on color mixture. After screeding the concrete basement floor to the proper level, a mixture of approximately 1 part portland cement and 1 to 1½ parts of sand and the required amount of pigment (Table III) is immediately dusted uniformly over the fresh concrete. This dry mixture should be woodfloated and worked into the concrete. Floating should be stopped as soon as the surface becomes wet, and resumed after the moisture disappears. The floor should be trued to grade and then steel-troweled smooth. The sand used in the dust-on mixture should be well graded with at least 80 per cent passing a No. 8 sieve and not more than 3 per cent passing a No. 30 sieve. The mixture should be applied at a rate not less than 125 lb. per 100 sq.ft. of floor area.

TABLE III — Pigments for COLORED CONCRETE Floors

Color desired	Commercial names of colors for use with cement	Approximate quantities required — lb. per bag of cement	
		Light shade	Medium shade
Greys, blue-black and black	Germantown lampblack*	½	1
	or carbon black*	½	1
	or black oxide of manganese*	1	2
	or mineral black	1	2
Blue	Ultramarine blue	5	9
Brownish red to dull brick red	Red oxide of iron	5	9
Bright red to vermilion	Mineral turkey red	5	9
Red sandstone to purplish red	Indian red	5	9
Brown to reddish-brown	Metallic brown (oxide)	5	9
Buff, colonial tint and yellow	Yellow ochre or	5	9
	yellow oxide	2	4
Green	Chromium oxide or	5	9
	greenish blue ultramarine	6	

*Only first-quality lampblack should be used. Carbon black is light in weight and requires very thorough mixing. Black oxide or mineral black is probably most advantageous for general use. For black use 11 lb. of oxide for each bag of cement.

Colored concrete floors can also be obtained through use of a good grade of commercial inorganic acid stain applied directly to the hardened concrete. The use of acid stains requires skill, and manufacturers' recommendations should be followed carefully. Stains properly applied will produce very attractive colored concrete floors.

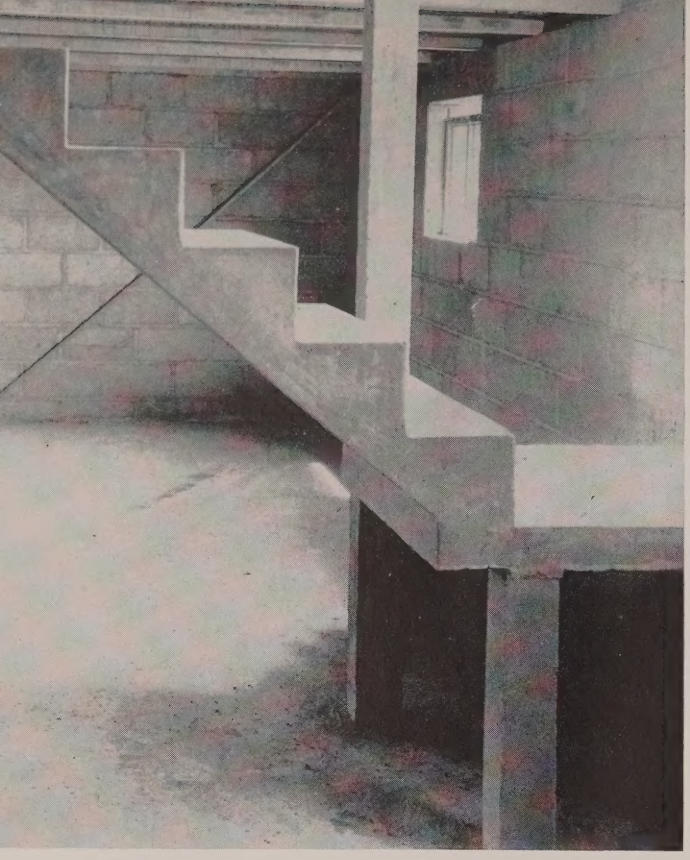
Oil paints, rubber-base paints and synthetic resin paints can be used to color concrete floors. It must be understood that any painted surface is subject to a certain amount of wear and may require retouching at intervals to maintain a good appearance. Portland cement base paints are not recommended for floor finishes.

Concrete should be clean and thoroughly dry when it is to be painted. The painting should not be done for several months after construction to give ample time for curing and drying. The surface should be neutralized by mopping it with a solution containing 4 lb. of zinc sulphate per gallon of water. After allowing 48 hours for this solution to react with the concrete and to dry, the surface should be cleaned with water to remove all crystals. It should then be allowed to dry thoroughly before applying the paint.

Three coats of paint are recommended. The first coat should be of thin consistency and have about equal parts of thinner and paint. Some thinner may be used for the second coat and the third coat may be applied as it comes from the container. In any event, all painting should be done in accordance with the manufacturers' recommendations.

Asphalt tile and wood flooring have proven popular, when surface covering is desired. Where other types of floor covering are contemplated, it is suggested that the manufacturer's recommendation be obtained as to suitability and method of application.

Asphalt tile provides an attractive floor covering.



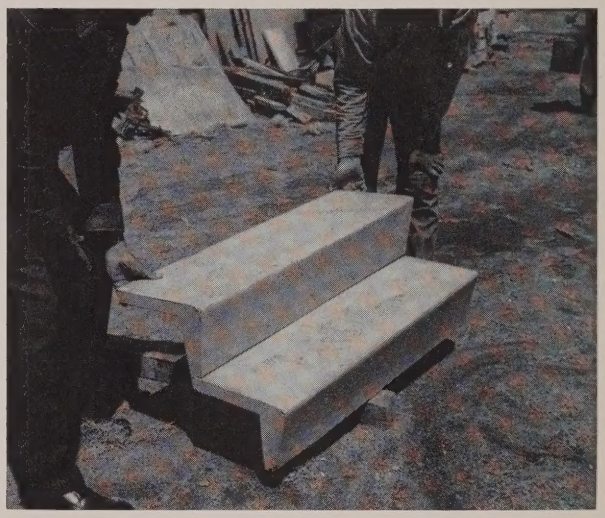
Cast-in-place concrete basement stairs.

Basement stairs of precast concrete units.

17 · Concrete Stairs

Concrete stairs provide strong, long-lasting and firesafe service between the basement and the first floor. Too often stairs are the focal point of serious fires. Concrete stairs, which can be constructed of either cast-in-place concrete or of precast concrete units, help to eliminate this hazard.

An outside stairway offers another safety outlet from the basement, as well as a time-saving shortcut from the laundry to the yard. In addition, garden tools and equipment stored in the basement are more easily accessible through a convenient entrance from the outside. A floor drain is usually placed at the bottom of these stairs to carry off any rain or snow that may accumulate.



Individual precast concrete stair units.

Outside stairway provides convenient access to yard.

18 • Quantities for Estimating

Tables IV, V, VI and VII contain information which will help the estimator determine the quantities of materials required for constructing concrete basements.

If aggregates are sold by weight, it may be assumed for estimating purposes that a ton contains approximately 22 cu.ft. of sand or crushed stone or about 20 cu.ft. of gravel.

TABLE IV—Quantities of Concrete Block and Mortar

Wall thickness	For 100 sq.ft. of wall		For 100 concrete block
in.	Number of block*	Mortar** Cu.ft.	Mortar** Cu.ft.
8	112.5	2.6	2.3
12	112.5	2.6	2.3

*Based on block having an exposed face of 7⅝ x 15⅝ in. and laid up with ⅜-in. mortar joints.
**With face shell mortar bedding — 10 per cent wastage included.

TABLE V—Quantities of Materials Per Cubic Foot of Mortar

Mortar mixes (volume)			Quantities			
Cement	Hydrated lime or lime putty	Sand in damp, loose condition	Masonry cement	Portland cement	Hydrated lime or lime putty	Sand
Sack	Cu.ft.	Cu.ft.	Sack	Sack	Cu.ft.	Cu.ft.
1 Masonry cement	—	3	0.33	—	—	0.99
1 Portland cement	1	6	—	0.16	0.16	0.97
1 Masonry cement plus 1 Portland cement	—	6	0.16	0.16	—	0.97
1 Portland cement	¼	3	—	0.29	0.07	0.86

1 sack masonry cement or portland cement = 1 cu.ft.

TABLE VI — Materials Required for 1 Cu.Yd. of Concrete

This table is based on use of average wet sand and on 3- to 4-in. slump. Quantities will vary according to grading of aggregate and workability desired. No allowance has been made for waste. 1 sack cement = 1 cu.ft. 4 sacks cement = 1 bbl.

Size of aggregate	Mixes				Yield of concrete per sack of cement	Materials per cu.yd. of concrete			
	Mixing water* per sack of cement	Portland cement	Aggregates			Water	Portland cement	Aggregates	
			Sand	Gravel or crushed stone				Sand	Gravel or crushed stone
	U.S. gal.	Sacks	Cu.ft.	Cu.ft.	Cu.ft.	U.S. gal.	Sacks	Cu.yd.	Cu.yd.
Maximum size ¾ in.	5	1	2½	2¾	4.3	31	6¼	0.58	0.64
Maximum size 1 in.	5	1	2¼	3	4.5	30	6	0.50	0.67
Maximum size 1½ in.	5	1	2¼	3½	4.7	29	5¾	0.48	0.75

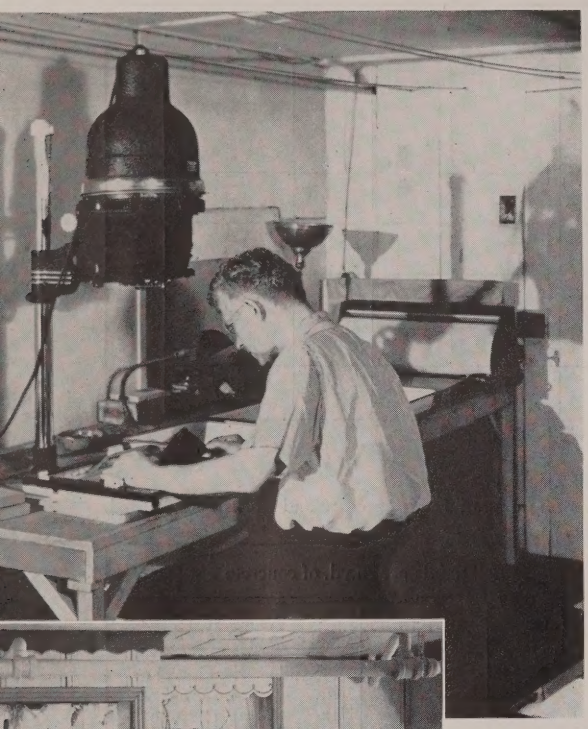
*Based on 6 gal. of water per sack of cement including water contained in average wet sand.

TABLE VII—Materials Required for 100 Sq.Ft. of Surface Area for Various Thicknesses of Concrete*

Thickness	Quantity of concrete	Mixes								
		1:2½:2¾			1:2¼:3			1:2¼:3½		
		Cement	Aggregate		Cement	Aggregate		Cement	Aggregate	
			Sand	Gravel or crushed stone		Sand	Gravel or crushed stone		Sand	Gravel or crushed stone
In.	Cu.yd.	Sacks	Cu.yd.	Cu.yd.	Sacks	Cu.yd.	Cu.yd.	Sacks	Cu.yd.	Cu.yd.
3	0.93	5.8	0.54	0.60	5.6	0.47	0.62	5.4	0.45	0.70
4	1.23	7.7	0.71	0.79	7.4	0.61	0.82	7.1	0.59	0.92
5	1.54	9.6	0.89	0.99	9.2	0.77	1.03	8.9	0.74	1.16
6	1.85	11.6	1.07	1.18	11.1	0.93	1.24	10.6	0.89	1.39
8	2.46	15.4	1.43	1.57	14.8	1.23	1.65	14.1	1.18	1.85
10	3.08	19.3	1.79	1.97	18.5	1.54	2.06	17.7	1.48	2.31
12	3.70	23.1	2.14	2.37	22.2	1.85	2.48	21.3	1.78	2.78

No allowance has been made for waste.
*100 sq.ft. of Portland cement plaster ½ in. thick requires 1.6 sacks of cement and 0.15 cu.yd. of sand.

Make your home more livable with a BASEMENT...



HERE are some of the many ways in which the basement may be used to increase the livability of the home. The concrete walls and floors can be left exposed and painted, or may be finished in other ways, or combined with other materials to meet the home owner's individual taste or requirements.

A basement provides the extra space every family needs for special activities . . . for storage . . . for better living. It also enhances the resale or loan value of the home.

PORTLAND CEMENT ASSOCIATION

33 West Grand Avenue **Chicago 10, Illinois**

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